REMARKS

I. Introduction

In response to the Office Action dated December 2, 2005, claim 14 has been have been amended. Claims 14-37 remain in the application. Re-examination and re-consideration of the application, as amended, is requested.

II. Claim Amendments

Applicants' attorney has made amendments to claim 14 as indicated above. The amendments were made solely for the purpose of clarifying the language of the claim, and were not required for patentability or to distinguish the claim over the prior art.

III. Restriction Requirement

In section (2) of the Office Action, claims 29-37 were withdrawn as being directed to a non-elected invention.

IV. Non-Art Objection

In section (3) of the Office Action, claim 14 was objected to due to certain informalities. Applicants' attorney has amended claim 14 to overcome this objection.

V. Prior Art Rejections

A. The Office Action Rejections

In sections (4)-(6) of the Office Action, claims 14-18 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,847,454 (Shaw) in view of U.S. Patent No. 4,923,716 (Brown) and U.S. Patent No. 6,902,656 (Ouellet). In section (7) of the Office Action, claims 27-28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Shaw, Brown and Ouellet as applied to claim 14, and further in view of U.S. Patent No. 6,780,672 (Steele).

However, in section (8) of the Office Action, claims 19-26 were indicated as being allowable if rewritten in independent form to include the base claim and any intervening claims.

Applicants' attorney acknowledges the indication of allowable claims, but respectfully traverse the rejections.

B. Applicants' Independent Claims

Applicants' independent claim 14 is directed to a method for fabricating microelectromechanical (MEMS) structures in a metal substrate. the method comprises the steps of providing a mask layer on a top surface of a metal wafer, patterning said mask layer to form a mask defining a MEMS structure, and deep etching the metal wafer through said mask using metal anisotropic reactive ion etching with oxidation to provide a first cavity corresponding to said MEMS structure in said metal wafer.

C. The Shaw Reference

Shaw describes a single mask, low temperature reactive ion etching process for fabricating high aspect ratio, released single crystal microelectromechanical structures independently of crystal orientation.

D. The Brown Reference

Brown describes silicon carbide that is deposited by chemical vapor deposition from a vapor source having a single molecular species that provides both the silicon and the carbon. The molecular species has the composition $C_nSi_nH_m$, where m ranges from 2n+1 to 4n+1 inclusive and n ranges from 2 to 6 inclusive, and exhibits a primary pyrolysis mechanism producing reactive fragments containing both silicon and carbon atoms. Unbalanced decomposition paths are avoided. The silicon and carbon atoms are necessarily codeposited in equal numbers and at equal rates onto the substrate, producing stoichiometric deposited silicon carbide. Preferred molecular sources include H.sub.3 SiCH.sub.2 CH.sub.2 SiH.sub.3, a silacycloalkane of the form $(\text{--}SiH_2CH_2\text{ --})_p$, where p is 2, 3, 4, or 5, and a cyclic structure of the form $(\text{--}SiH(CH_3)\text{--})_q$, where q is 4 or 5.

E. The Ouellet Reference

Ouellet describes a cavity forming formed in an encapsulation structure under a vacuum in a vacuum chamber is sealed with a capping layer. A stiff protective layer under tensile stress is deposited on the capping layer prior to venting the vacuum chamber to atmospheric pressure. The capping layer is preferably aluminum or an aluminum alloy, and the protective layer is preferably δ-TiN having a suitable high Young's modulus.

F. The Steele Reference

Steele describes micro electromechanical, MEM, components that are created which include at least one integrated circuit die (110p). A cavity in the MEM component modules (300a, 300e) further allows for the flush mounted attachment of component modules when the component modules are stacked to create MEM system structures. Commonly positioned via holes within the component modules provide for communication among the dies (110a, 110b, 110c) on the stacked modules. In one embodiment of the invention, module layers are stacked in an alternating manner that further creates, within in the structure horizontal interlocking slots and vertical chambers. The interlocking slots can be used to join a plurality of structures together and the vertical chambers can be used to draw heat from the structure (400).

G. The Applicants' Invention is Patentable Over the References

Applicants' attorney respectfully submits that the claims are patentable over the references. Specifically, Applicants' independent claim 14 recites limitations not shown in the references, taken individually or in combination.

The Office Action, on the other hand, asserts that Shaw teaches most of the limitations of independent claim 14 directed to fabricating MEMS structures in a substrate. The Office Action does admit, however, that Shaw does not disclose a metal wafer. Nonetheless, the Office Action states that this limitation is taught in Brown, where a process for forming a semiconductor device on a metal substrate (titanium carbide or TiC) is disclosed. The Office Action argues it would have been obvious to replace the silicon substrate in Shaw with the TiC substrate in Brown because the substitution would be a mere substitution of art-recognized equivalent values, MPEP 2144.06. Further, the Office Action cites Ouellet as disclosing that TiC would have provided a substrate having a better Young's modulus than a silicon substrate. The Office Action argues it would have been obvious to use the teachings of Ouellet with Shaw and Brown's teaching for the intended purpose, MPEP 2144.07.

Applicants' attorney disagrees.

Applicants' independent claim 14 recites a method for fabricating microelectromechanical (MEMS) structures in a metal substrate, comprising: providing a mask layer on a top surface of a metal wafer; patterning said mask layer to form a mask defining a MEMS structure; and deep etching the metal wafer through said mask using metal anisotropic reactive ion etching with oxidation to provide a first cavity corresponding to said MEMS structure in said metal wafer.

Even when combined, the references do not teach or suggest the limitation of independent claim 14 directed to "deep etching the metal wafer through said mask using metal anisotropic reactive ion etching with oxidation."

Instead, Shaw merely discloses a method for fabricating a non-metal MEMS device comprising of (1) placing a mask layer on top of a silicon substrate, (2) patterning the mask layer, and (3) subsequently etching the substrate through the mask layer using deep anisotropic reactive ion etching (RIE). However, a metal anisotropic reactive ion etch of a metal wafer is not disclosed by Shaw.

In addition, Brown merely discloses a process for depositing a semiconductor (silicon carbide or SiC) on a metal substrate (TiC). However, like Shaw, a metal anisotropic reactive ion etch of a metal substrate is not disclosed by Brown.

Finally, Ouellet merely discloses a method for depositing a metal, TiC, as a stiffening and sealing layer on top of a MEMS device. However, like Shaw and Brown, a metal anisotropic reactive ion etch of a metal wafer is not disclosed by Ouellet.

Thus, the combination of references does not teach or suggest all the limitations of Applicants' claim 14. Moreover, the proposed combination of Shaw, Brown and Ouellet would not perform in the manner suggested by the Office Action.

For example, combining Shaw and Brown would result in a method of fabricating a semiconductor/metal MEMS device comprising the steps of (1) placing a mask layer on top of a SiC layer deposited on TiC, (2) patterning the mask layer and (3) subsequently etching the SiC layer. The result would be an etched SiC layer, not an etched metal wafer as in claim 14.

Further, the citation to MPEP 2144.06 is inappropriate, since it refers to combining two compositions, each of which is taught by the prior art to be useful for the same purpose. This is not the case with Shaw and Brown, however, since these references teach different purposes. The purpose of the substrate in Shaw is to use the substrate as a MEMS device, whereas the purpose of the substrate in Brown is to use the substrate as a carrier wafer.

Finally, the Office Action cites Ouellet to show that it would have been obvious to select metal as a substrate in a MEMS device, in accordance with MPEP 2144.07. Ouellet, however, discloses a method for depositing a metal, TiC, as a stiffening and sealing layer on top of a MEMS device, wherein the stiffening layer is chosen for its high Young's Modulus (See Ouellet, col. 14 lines 63-67).

The Applicants' invention, on the other hand, uses metal as a MEMS material for entirely different reasons, such as lower cost, ease of pre-machining and ease of deformation. These were not considerations in Ouellet, and in fact, Ouellet teaches away from the Applicants' invention since a high Young's modulus is not a desired characteristic in the Applicants' device. A high Young's modulus makes the device less deformable and machineable. Thus, Ouellet does not teach that it would have been obvious to use a metal substrate in a MEMS device.

Finally, Steele does not overcome the deficiencies of Shaw, Brown, and Ouellet. Recall that Steele was cited only against dependent claims 27-28, and only for the proposition of stacking and bonding multiple substrates to form an enclosed package.

Thus, Applicants submit that independent claims 14 is allowable over Shaw, Brown, Ouellet and Steele. Further, dependent claims 15-28 are submitted to be allowable over Shaw, Brown, Ouellet and Steele in the same manner, because they are dependent on independent claim 14 and thus contain all the limitations of the independent claim. In addition, dependent claims 15-28 recite additional novel elements not shown by Shaw, Brown, Ouellet and Steele.

VI. Conclusion

In view of the above, it is submitted that this application is now in good order for allowance and such allowance is respectfully solicited. Should the Examiner believe minor matters still remain that can be resolved in a telephone interview, the Examiner is urged to call Applicants' undersigned attorney.

Respectfully submitted,

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